Part Four:

Findings and Recommendations

Findings and Recommendations

The section focuses on the essential findings of this 1995 revision of the interagency study on orbital debris. These findings highlight changes that have occured since the publication of the 1989 Report on Obital Debris. In addition five specific recommendations are proposed to address the issues raised by this report.

Summary of Findings

The 1989 Report on Orbital Debris noted the lack of definitive measurements on the debris environment. Since that time NASA, with the assistance of DOD, has conducted an extensive program to measure the LEO debris environment. There has now emerged a comprehensive picture of the orbital debris environment in LEO. The current Haystack measurements indicate populations a factor of two lower than predicted in 1989 at Space Station altitudes and a factor of two higher at the 1000 km altitude. In GEO, however, NASA has only conducted an exploratory campaign to measure the debris environment. Both of these efforts should continue in order to refine our understanding of the current environment as well as to monitor changes in the environment with time.

Contributions to the current debris environment continue to be essentially proportional to the level of space activity by a given spacefaring nation. Of particular concern is the sustained rate of fragmentation events since 1989 despite the active efforts of the spacefaring nations to reduce the probability of such occurrences.

The orbital debris environment in LEO continues to present problems for space operations that involve large spacecraft in orbit for long periods of time. Taking note of all that has been learned since 1989, the International Space Station Program has taken steps to maximize protection from debris penetration by implementing state-of-the-art shielding; utilizing existing ground radars to track and avoid larger debris; and actively developing operational and design options which will minimize the risk to the crew and the Station.

Since release of the 1989 Report, there have been a series of proposals to develop large LEO satellite constellations. These constellations could present a significant new concern for the orbital debris environment. For those constellations which have a large aggregate area, the collision probabilities are sufficiently high that additional means of protection need be considered. The problem is particularly acute because the high inclination of their orbits lead to high spatial density over the poles.

The development and utilization of predictive models has improved significantly since 1989. This improved predictive capability when combined with our increased knowledge of the debris environment, leads to the conclusion that failure to take any mitigation action could lead to significant increase in orbital debris in the coming years. Assuming a continuation of launch activity at the same average rate as over the last ten years, average future solar cycles, and future operational practices that will minimize but not eliminate the possibility of explosions in orbit, most models predict that an increasing fraction of future debris will originate from breakups due to random collisions between orbiting objects. The use of operational practices to limit the orbital lifetime of spent upper stages and payloads have the potential to mitigate the growth of orbital debris.

In 1989 National Space Policy Directive-1 (NSPD-1) was approved. NSPD-1 called for agencies to “seek to minimize the creation of space debris.” Since that time orbital debris concerns have caused changes in the plans and activities of some agencies, particularly NASA. NASA has issued a comprehensive agency policy concerning orbital debris. The Department of Defense (in particular the Air Force and the U.S. Space Command) have adopted broad policies concerning orbital debris. Beyond the general statement in NSPD-1, there remains no comprehensive statement of USG policy on orbital debris.

The 1989 Report called for NASA and the DOD to develop a plan to monitor the orbital debris environment. Since that time NASA, utilizing many DOD assets and NASA’s own capabilities, has expended considerable effort to accomplish this recommendation. The modification of the Haystack Radar for orbital debris measurements has greatly enhanced our ability to monitor the LEO debris environment. Today, data measurements as well as data management limitations significantly affect the capability of the Space Surveillance Network to detect and track smaller debris objects. Statistical techniques are being utilized to characterize the current debris population.

Since the publication of the 1989 Report, the United States and a number of national and international spacefaring organizations have begun to address orbital debris concerns. As a result of the recommendations set out in the 1989 Report, the United States and other spacefaring nations have taken voluntary design measures (i.e., tethering of operational debris such as lens caps and the use of debris free devices for separation and release) as well as operational procedures to prevent the generation of orbital debris. More than ever, it is clear that closer international cooperation is necessary for dealing effectively with orbital debris. It is in the broad interest of the United States to continue to maintain a leadership role in international considerations relating to orbital debris. The United States considers the development of technical cooperation and consensus to be a prerequisite for any potential international agreements, regulatory regimes or other measures relating to orbital debris. The unilateral application of debris mitigation measures could put U.S. satellite and launch vehicle industries at a competitive disadvantage.

Recommendations

In light of the findings contained in this revision of the 1989 Report on Orbital Debris, and noting the progress that has been made in our understanding of the debris environment, the following recommendations should be implemented.

1. Continue and Enhance Debris Measurement, Modeling and Monitoring Capabilities

Our ability to fully understand the orbital debris problem will depend upon our continuing capabilities to measure, model and monitor the debris environment. NASA and DOD should continue current investments in their debris research programs and, as resources permit, seek to expand existing measurement capabilities (both radars and optical systems) and bring new systems now under development on line as soon as possible. NASA should continue its program of returned material analysis and seek additional opportunities to exchange samples with other spacefaring nations. DOD and NASA should closely coordinate their laboratory studies of breakups from explosions and collisions. Particular attention should be given to those orbits where critical national security payloads may be located, where permanent presence is planned (i.e., the Space Station orbit), in geosynchronous orbits, and in the economically and scientifically critical sun-synchronous orbits.

2. Conduct a Focused Study on Debris and Emerging LEO Systems

To date, government involvement has focused primarily on the frequency licensing issues associated with these systems. To ensure that other considerations pertinent to these systems are adequately understood and reviewed, NASA, with the participation of DOD, DOT, DOC, and other relevant federal agencies should convene a workshop with U.S. industry on debris mitigation and LEO systems. The workshop should serve as a first step in identifying possible measures for debris mitigation that LEO operators could incorporate in the design of future systems. The workshop could also identify possible mitigation measures for launch vehicle operators contemplating service for LEO systems. This effort should include appropriate analysis of the economic impacts that specific mitigation measures could have on the satellite and launch vehicle communities. NASA should document the results from this workshop in a report and factor these results into government/industry efforts to develop guidelines on debris mitigation (see Recommendation 3).

3. Develop Government/Industry Design Guidelines on Orbital Debris

NASA has made substantial progress in documenting and defining specific design measures that can be taken into account during the development of spacecraft and launch vehicles in order to minimize or eliminate debris generation. Using this initial work, NASA and DOD should jointly develop draft design guidelines that could serve as a baseline for agency requirements for future spacecraft and launch vehicle/service procurements. Upon completion of the draft guidelines, NASA and DOD should disseminate the draft to industry for comment and convene a workshop to discuss industry and government concerns. This workshop should also seek to identify design guidelines which would require international consensus in order to ensure a fair and level playing field. The goal of the exercise would be the development of Government/Industry guidelines that both sectors could use in the design and development of future systems.

4. Develop a Strategy for International Discussions

Since the 1989 report was issued, three important international developments related to debris have taken place. First, through NASA's efforts, an international agency-level organization (the Inter-Agency Space Debris Coordination Committee) has been formed to facilitate the exchange of technical research and information

related to debris. The United States, Japan, ESA, Russia, and China currently have agency-level representation on the committee. Planning for membership of other spacefaring nations is underway. Second, the United States introduced detailed analysis on the problem of the safing and disposal of geostationary satellites to relevant working groups in the International Telecommunication Union. Third, the United States joined consensus with other members of the Scientific and Technical Subcommittee of the United Nations Committee on Peaceful Uses of Outer Space to take up the subject of space debris as a formal agenda item.

The United States should maintain its leadership role in these forums, but seek to do so in a more coordinated and comprehensive way. The Department of State and NASA, with the participation of other relevant agencies, should co-chair a review to develop a strategy outlining how the United States should seek to encourage other spacefaring nations to adopt debris policies and practices and how current bilateral and multilateral discussions can be better coordinated. In developing this strategy the United States government should take into account the need to ensure that a level playing field is created in the application of international orbital debris mitigation policies and practices.

5. Review and Update U.S. Government Policy on Debris*

National Space Policy Directive-1 (NSPD-1), signed in 1989, includes an Intersector Policy guideline calling on agencies to "seek to minimize the creation of space debris." Under NSPD-1, design and operation of space tests, experiments, and systems will strive to minimize or reduce accumulation of space debris consistent with mission requirements and cost effectiveness. NSPD-1 calls on the government to encourage other spacefaring nations to adopt policies and practices aimed at debris mitigation and minimization.

On June 2, 1995, the President directed the OSTP and NSC to lead a comprehensive review of National Space Policy, including policies affecting the civil, commercial, and national security space sectors. As part of this review, the Administration should seek to translate the recommendations contained in this report, as appropriate, into national policy concerning agency programs and activities related to orbital debris.

---

* The findings and recommendations contained in this report were transmitted to the Interagency Working Group for Space Policy in November 1995